Characteristics of Israeli School Teachers in Computer-based Learning Environments

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Abstract

The purpose of this research is to investigate whether there are differences in the level of computer literacy, the amount of implementation of ICT in teaching and learning-assessment processes and the attitudes of teachers from computerized schools in comparison to teachers in non-computerized schools. In addition, the research investigates the characteristics of Israeli school teachers in a 21st century computer-based learning environment. A quantitative research methodology was used. The research sample included 811 elementary school teachers from the Jewish sector of whom 402 teachers were from the computerized school sample and 409 were teachers from the non-computerized school sample. The research findings show that teachers from the computerized school sample are more familiar with ICT, tend to use ICT more and have a more positive attitude towards ICT than teachers in the non-computerized school sample. The main conclusion which can be drawn from this research is that positive attitudes of teachers towards ICT are not sufficient for the integration of technology to occur. Future emphasis on new teaching skills of collective Technological Pedagogical Content Knowledge is necessary to promote the implementation of optimal pedagogy in innovative environments.

Key words: teachers' attitudes, teaching in an online environment, professional development of teachers, Technological Pedagogical Content Knowledge (TPACK)

Introduction

The introduction of computerized tools into the educational system will undoubtedly create many changes in teaching, learning and thinking processes. It is thought that these changes will give

rise to an optimal pedagogy that will influence the curriculum, the teachers, the learners and the learning environment (Harris & Hofer, 2009; Kali, 2006; Vidislavsky, Peled & Pavsener, 2010).

Research shows that introducing innovations in instructional methods in the schools is met with many difficulties. The main factors influencing the implementation of technological pedagogy in the schools are teachers' beliefs, perceptions, skills and attitudes towards digital environments and towards the role of the teacher in these environments (Cunningham, 2009; De Freitas & Oliver, 2005; Halverson & Smith, 2010; Selwyn, 2010). The present research focuses on the factors that influence pedagogical implementation of information technology in the classroom. One of the factors influencing the effective implementation of innovative technology in the schools is the skills of the teacher as a pedagogical and professional expert (Davidson, Schofield & Stocks, 2001; Koehler & Mishra, 2008; Nachmias, Miodosser & Farkash-Baruch, 2009; Wallace, 2004).

Soloman (2000) claims that in order for technology to be of high quality and to provide significant support for teaching and learning processes, and for teachers to acquire professional knowledge concerning how to use technology in educated ways, it is necessary to define a pedagogical rationale to guide the implementation of technology. Long-term, significant guidance, that combines relevant pedagogical instruction with hands-on practice in implementing the new technology in the classroom, would support an attitudinal change needed to allow teachers to adopt such programs (Davis & Varma, 2008; Fishman, Mark, Blumenfeld, Krajcik & Soloway, 2004; Furman-Shaharabani & Tal, 2008; Vrma, Husic & Linn, 2008).

The research questions are as follows:

1. To what extent will differences be found in the level of expertise in the use of office applications, the level of communication skills, the implementation of technological

pedagogy and the attitudes towards technology between teachers of the computerized school sample and the teachers of the non-computerized school sample?

2. What are the characteristics of the teacher in a computerized environment of the 21st century?

Literature Review

The major barrier to teachers' implementation of technology in education is their attitudes towards the role of technology and their ability to successfully implement it. Therefore, if teachers believe that technology should be used, and if they have the ability to use it in practical ways, they will implement technology in classroom instruction (Anderson & Maninger, 2007; Bitner & Bitner, 2002; Brinkerhoff, 2006).

Teachers' Attitudes Towards ICT

The term "attitude" refers to relatively stable orientations of the individual towards different types of objects. Gardner (1985) claims that attitude is an evaluative reaction to some referent or attitude object, inferred on the basis of the individual's beliefs or opinions about the referent.

Gardner's argument led Wenden (1991) to present a comprehensive definition of the attitude concept. He classified the term "attitude" into three interrelated components namely, cognitive, emotional and behavioral. The behavioral, conative component includes the individual's mode of action towards the object; the cognitive component relates to the individual's opinion towards that same object from rational considerations and claims; and the emotional component refers to the individual's attitude towards a particular object or event. Attitudes can reflect positive, negative, or neutral attitudes to an object (Eagly & Chaiken, 1993).

Later, other researchers identified attitude "as determined by the individual's beliefs about outcomes or attributes of performing the behavior (behavioral beliefs), weighted by evaluations

of those outcomes or attributes. Thus, a person who holds strong beliefs that positively valued outcomes will result from performing the behavior will have a positive attitude toward the behavior. Conversely, a person who holds strong beliefs that negatively valued outcomes will result from the behavior will have a negative attitude." (Montano & Kasprzyk, 2008, p. 71).

According to Ajzen's (1991) Planned Behavior Theory attitude affects behavior through a process of planned decision-making. The decision to deal with a particular behavior is rational and not spontaneous; it is the result of the intention to perform it and the amount of effort that a person is prepared to invest. The intention to behave in a particular way is likely to predict future behavior, and is influences by three factors: (1) Attitudes towards behavior – the degree to which a person evaluates behavior as positive or negative; (2) Subjective norms – the perception of what people, who are important to the individual, will say regarding the performance or non-performance of a behavior; and (3) perceived behavioral control – the extent to which an individual evaluates a behavior in a light or harsh manner.

Researchers assert that the more positive are the attitudes towards the subjective behavior and the norms and the greater the behavioral control is perceived, so will the behavioral intentions be stronger (Doll & Ajzen, 1992), and the stronger the intentions, the greater the chance of implementing the behavior (Schifter & Ajzen, 1985). The theory assumes that behavior is an indirect result of information or relevant behavioral beliefs towards the behavior, so that each of the factors bearing influence is derived from behavioral beliefs. This theoretical model is likely to afford a paradigm for developing intervention that is directed towards change in human behavior (Ajzen, 2002), which, in this study, is the teachers' behavior in an ICT environment.

Jack and Horowitz (1985) claim that in the course of teachers' work, their attitudes are likely to influence their instructional behavior concerning their choice of instructional strategies.

Therefore, implementation of technology in innovative environments is significantly connected to teachers' attitudes and to their beliefs concerning the place of technology in their teaching.

Positive attitudes of teachers towards implementing technology contribute to its further implementation. Teachers who see the advantages of using computers in instruction attribute importance to foreseen difficulties (Nachmias et al., 2009). Teachers who experience success in technological environments develop positive attitudes towards their instructional ability in the classroom (Abu-Dagga & Huba, 1997). Other studies show that teachers with positive attitudes toward technology use their pedagogical knowledge to influence their instructional strategies and their willingness to implement change in their work (Shamir-Inbal & Kali, 2011).

What Teacher Knowledge Is Needed in an ICT Environment?

The ICT learning environment demands of the teacher to function as an architect/designer of the curriculum and of the learning and evaluation experience in order to achieve defined objectives that are adapted to the students' needs. Koehler and Mishra (2008) propose expanding the concept of teacher's knowledge, coined by Shulman (1986), and adding additional knowledge – Technological Pedagogical and Content Knowledge (TPACK). This knowledge characterizes the teachers' ability to integrate technology in his teaching in an educated manner. Koehler and Mishra (ibid) opine that developing a curriculum, integrated with technology, necessitates three types of knowledge: technological knowledge, pedagogic knowledge and content knowledge. These three types of knowledge partially overlap and at their intersection offer:

- Content knowledge- concepts, content, ideas, skills, methods of constructing the knowledge in a particular subject/ field.
- Pedagogic content knowledge- how to teach particular contents.
- Technological content knowledge- how to select and use technology to convey particular content knowledge.

- Technological- pedagogical content knowledge- how to use particular technologies for teaching.

Harris and Hofer (2009) suggest that when teachers plan pedagogic activity combined with technology they must take five basic decision: (a) a decision regarding the learning purpose; (b) pedagogic decision-taking that is suitable to the type of learning experience; (c) the choice of a series of activities that are suitable to shaping the learning experience; (d) choosing formative and summary evaluation strategies in order to explore how students learn well; (e) an educated choice of tools and resources in order to help students to achieve the learning experience they plan.

Their research findings show that teachers with positive attitudes are teachers who have mastered computer skills and ICT that lead to mastery of technological-pedagogical content knowledge, which includes the educated integration of information technologies. The findings even support the conclusion that technological-pedagogical content knowledge is complex knowledge, and the greater the teacher's mastery of it, so his fears of change will decrease and his attitudes towards the change will be more positive. Mastery of this knowledge will make teaching with technology in the classroom challenging and not threatening. The ability to combine pedagogical knowledge, knowledge in the field of content and technological knowledge (TPACK) is an acquired ability that improves with practice.

In 2011 the Israeli Ministry of Education embarked on the application of a new national computerization program, known as "Adapting the education system to the 21st century", in 200 non-computerized elementary schools from the country's periphery, in order to reduce the digital gap. It was also implemented in 20 special computerized elementary schools that were continuously and consistently involved with educational, pedagogical and organizational ICT-focused innovation.

The Research Hypothesis

Differences will be found in the level of skill using office tools, in the level of communications skills, in the application of pedagogy in a technological environment, and in attitudes towards ICT between teachers in computerized schools and teachers in non-computerized schools.

- Teachers in computerized schools demonstrate a level of skill using office tools greater than that of teachers in non-computerized schools.
- Teachers in computerized schools demonstrate a higher level of communications skills than teachers in non-computerized schools.
- Teachers in computerized schools apply pedagogy in a technological environment to a greater extent than teachers in non-computerized schools.
- Teachers in computerized schools hold more positive attitudes towards ICT than teachers in non-computerized schools.

Method

Participants

This study randomly sampled 811 elementary school teachers (16%) from 5000 teachers who participated in Israel's new national ICT program called "Adaptation of the Educational System to the 21st Century" (Ministry of Education, 2011).

Of these, 409 (50.4%) were teachers from non-computerized schools and 402 (49.6%) were teachers from computerized schools. Computerized schools were defined as schools which demonstrate broader integration of ICT along with the use of advanced pedagogical processes on an ongoing basis for educational innovation. Non-computerized schools were schools that were not specifically unique in their focus on technology.

Tools

Teachers were asked to respond to a questionnaire that was composed of four subjects: skills in the use of office, communication skills, pedagogy in a technological environment and attitudes toward technology.

The questionnaire contained 48 items, of which 41 items examined the knowledge and level of use of skill using office, communications skills and the quality of the pedagogy in a technological environment. The teachers were asked to respond to the questions using a three-rank Lickert scale, wherein 1 indicated unfamiliar, 2 – familiar but do not use, and 3 – familiar and use. The higher the score, the better the teacher's ICT skill. Furthermore, the teachers were asked to relate to seven items pertaining to attitudes towards ICT that examine the degree of agreement to statements on a four-rank Lickert scale, wherein 1 indicated do not agree, 2 – agree to some extent, 3 – agree, 4 - fully agree. The higher the score, the more positive the teacher's attitudes towards ICT. Reliability analysis and inner consistency of the questionnaire according to Cronbach's alpha was α=.95 (see questionnaire in Appendix 1: details of the questionnaire indices).

Skill using office

The questionnaire comprised 11 items (numbers 3-13) that explore the knowledge and level of use of basic skills of word processing, constructing a presentation and data processing – electronic spreadsheet, analysis of reliability and inner consistency of the scale. This was calculated according to Cronbach's alpha with a result of α=.91

Communications skills

The questionnaire comprised 11 items (numbers 1-2, and 14-22) that explore the knowledge and level of use of technological communications skills. Reliability and inner consistency analysis of the scale, calculated according to Cronbach's alpha was α=.80.

Pedagogy in a technological environment

The questionnaire comprised 18 items (numbers 23-41) that examine the knowledge and level of use of innovative pedagogical skills that combine information and communication technologies in the classroom. Reliability and inner consistency analysis of the scale, calculated according to Cronbach's alpha was α =.93.

Attitudes towards ICT

The questionnaire comprised seven items (numbers 42-48) that examine the teachers' attitudes towards ICT. Reliability and inner consistency analysis of the scale, calculated according to Cronbach's alpha was α= .93.

In addition, background information on the teachers was gathered, such as gender, education and teaching experience.

The teachers answered the questionnaire in the framework of school in-service training intended for professional development in the realm of ICT, doing so online in the beginning using the Google Docs application. This took about 30 minutes. Some 60% of the teachers completed the questionnaire.

Data Analysis

Coding and statistical analysis of the data were performed using the SPSS 19.0 for windows program. Completing the questionnaire took 30 minutes and 60% of the teachers performed this task. The research hypotheses were checked using pathways methodology of Structural Equation Modeling (SEM) with the aid of the statistical program, Analysis of Moment Structures (AMOS 7.0) (Arbuckle, 2006).

A causal model for studying phenomena is usually intended to provide an explanation for a particular phenomenon resulting from the existence of the previous phenomenon. Laying the time sequence relative to the observed phenomenon discovered, in our case implementing innovative pedagogy in class, is essential not only for drawing causality, but for exploring the relative significant size of the other variables in the model (Bentler & Weeks, 1979). The

assumptions underlying measurement without error and the uncorrelated residuals or error terms are not realistic in the social and behavioral sciences. Moreover, many of the variables studied in these sciences in general, and in this study in particular, cannot be observed directly, and are, in essence complex, multi-dimensional concepts that are hard to validate and afford reliability with individual indicators (Pedhazur, 1982; Schumn, Southerly & Figley, 1980). Consequently, the approach was adopted according to which techniques for analyzing causal models, such as SEM, are preferable to the study of complex theoretical models in which variables are presented that influence each other on a particular sequence, and can be analyzed simultaneously (Lavee, 1988). In recent years, the validity and reliability of empirical measurements have been attained in multi-variable analysis of causal models. These approaches are based on a methodological-statistical-philosophical concept to examine hypotheses regarding the connections between observed variables and latent variables (Hoyle & Panter, 1995).

The SEM model includes two parts: a measurement model and a structural model. From the methodological perspective it manifests the necessary combination demanded of every research.

Evaluating the measurement model was explored through four indices that indicate the degree of compatibility between the model and the data. The indices examined were the RMSEA (Root Mean Square Error of Approximation), one of the main indices whose importance was recently determined. In general, this index testifies to the rate of variance remaining unexplained after applying the NFI model (Normed Fit Index). This is the normal fit index obtained through the use of an estimated model relative to the compatibility of the zero model. The CFI (Comparative Fit Index) is based on the same comparison performed for the NFI index, taking into account the sample size and an $\chi 2$ likelihood Ratio Test (Bentler & Bonett, 1980). The lower and more insignificant the $\chi 2$ value, so the lack of compatibility obtained is random (Klem, 2000). This means that the model is compatible with the data. This index is influenced by the size of the

sample. Thus if the sample is very large in size, a "good" model will also be rejected, hence its efficiency is doubtful (Hoyle & Panter, 1995; Kline, 2005). A more reliable index 2/df (χ Normed χ^2) is considered a good fit, when the RMSEA value is .05 or less. This manifests a close fit. When the value is .08 or less it indicates a structural fault, and when it is greater than .1 the model should be rejected. The closer the NFI and the CFI values are to 1, the greater the degree of compatibility (Bentler, 1992; Byrne, 1989; Hoyle & Panter, 1995; Thompson, 2000). A cutoff value has recently been proposed that is close to .95, representing a good fit of the assumed model to the data (Byrne, 2009). The findings of the pathways analysis will be presented in two stages – analysis of the measurement model, and examination of the structural model and confirmation of the research hypotheses.

Findings

T tests were performed on the independent variables (Table 1) to find the differences in the use of office applications, the level of communication skills, the implementation of technological pedagogy and the attitudes towards technology between teachers of computerized schools and teachers of non-computerized schools.

Table 1
The Means, Standard Deviations and Results of t Tests

		computerized school *N*=402		non-computerized school *N*=409		t (df=809)
		M	***S.D***	***M***	***S.D***	
Office tool skills		2.69	0.39	2.48	0.53	-6.26**
	Word processor	2.78	0.39	2.56	0.58	-6.23**
	Building presentations	2.34	0.71	2.06	0.78	-5.39**
	Data processor-Excel sheet	2.04	0.76	1.81	0.79	-4.23**
Communication skills		2.69	0.28	2.57	0.40	-5.01**
	Management of personal information	2.93	0.26	2.82	0.48	-4.23**
	Use of tools for pedagogical management	2.56	0.54	2.43	0.65	-3.13**
	Internet use	2.87	0.33	2.77	0.46	-3.65**
	Communications network	2.51	0.41	2.38	0.51	-4.08**
Technological pedagogy		2.09	0.67	1.93	0.53	-3.83**
	Instructional strategies	2.36	0.87	2.10	0.64	-4.70**
	Writing processes	2.15	0.71	1.93	0.55	-5.14**
	Assessment of learners	1.84	0.71	1.80	0.60	-0.92**
Attitudes towards technology		3.41	0.49	3.27	0.64	-3.74**
	Attitudes towards behavioral aspects	3.41	0.54	3.26	0.66	-3.62**
	Attitudes towards emotional aspects	3.57	0.51	3.44	0.66	-3.29**
	Attitudes towards cognitive aspects	3.31	0.57	3.16	0.71	-3.40**

** $p<.01$

The results of the *t* tests show significant differences in the level of office tool skills, in communication skills, in implementation of technological pedagogy and in the attitudes towards technology between teachers of the computerized school sample and the teachers of the non-computerized school sample. Namely, teachers in computerized schools are more familiar with,

and use, office tool skills more often, have better communication skills, use pedagogical technology more, and have better attitudes towards technology than teachers in the non-computerized schools.

The current research suggests a multi-variable model for two groups: the computerized school sample and the non-computerized school sample. The assessment of the model was done by examining the measurements which point to the compatibility of the model to reality. Table 2 presents four fit indices, χ^2, RMSEA, NFI and CFI, that show the compatibility of the model to reality (Bentler & Bonett, 1980), according to the values of the measurements of the pathway model that was performed on the answers to the questionnaire of 811 teachers.

Table 2
Fit Indices According to the Values of the Measurements of the Pathway Model

fit indices	values
(df=120) χ^2	560.000***
CFI	.92
NFI	.91
RMSEA	.068

*** $p<.001$

The results of the model presented in Table 1 show that the value of χ^2 with a fit of 120 degrees of freedom is statistically significant at 560.000, a value that points to a significant gap between the data (Matrix S) and the covariance of the model (Matrix Σ). It is likely that that this result was influenced by the large number of subjects (N=811) (Bentler, 1992; Bentler & Bonett, 1980; Klem, 2000). However, the other values of the measurements point to a good fit between the model and the data. The RMSEA measurement (.068) is less than .08 and the NFI measurement

(.906) and the CFI measurement (.924) approach 1. These measurements provide the most fundamental indication of how well the proposed model fits the data.

The pathways model also shows the causal connections between the variables of two kinds: exogenic variables that are not influenced by other variables of the model and endogenic variables that are influenced by other variables of the model (Byrne, 2001, 2009).

The exogenic variable in this study is the attitudes towards technology that include three measurements: the behavioral, emotional and cognitive aspects. The endogenic variables are the ability to use office tools, the communicative skills and pedagogy in a technological environment. The endogenic variable, the ability to use office tools, includes three measurements: knowledge of word processing, knowledge of creating a presentation and knowledge of data processing. The endogenic variable, communication skills, includes four measurements: management of personal information, tools for pedagogical management, online communication, and internet surfing. The endogenic variable, pedagogy in a technological environment, include three measurements: instructional strategies, writing processes and the evaluation of learners. Figure 1 presents the data analysis according to schools, the standardized coefficients (β) between the exogenic variable and the endogenic variables and between the endogenic variables and the explained variance (R^2) of the endogenic variables.

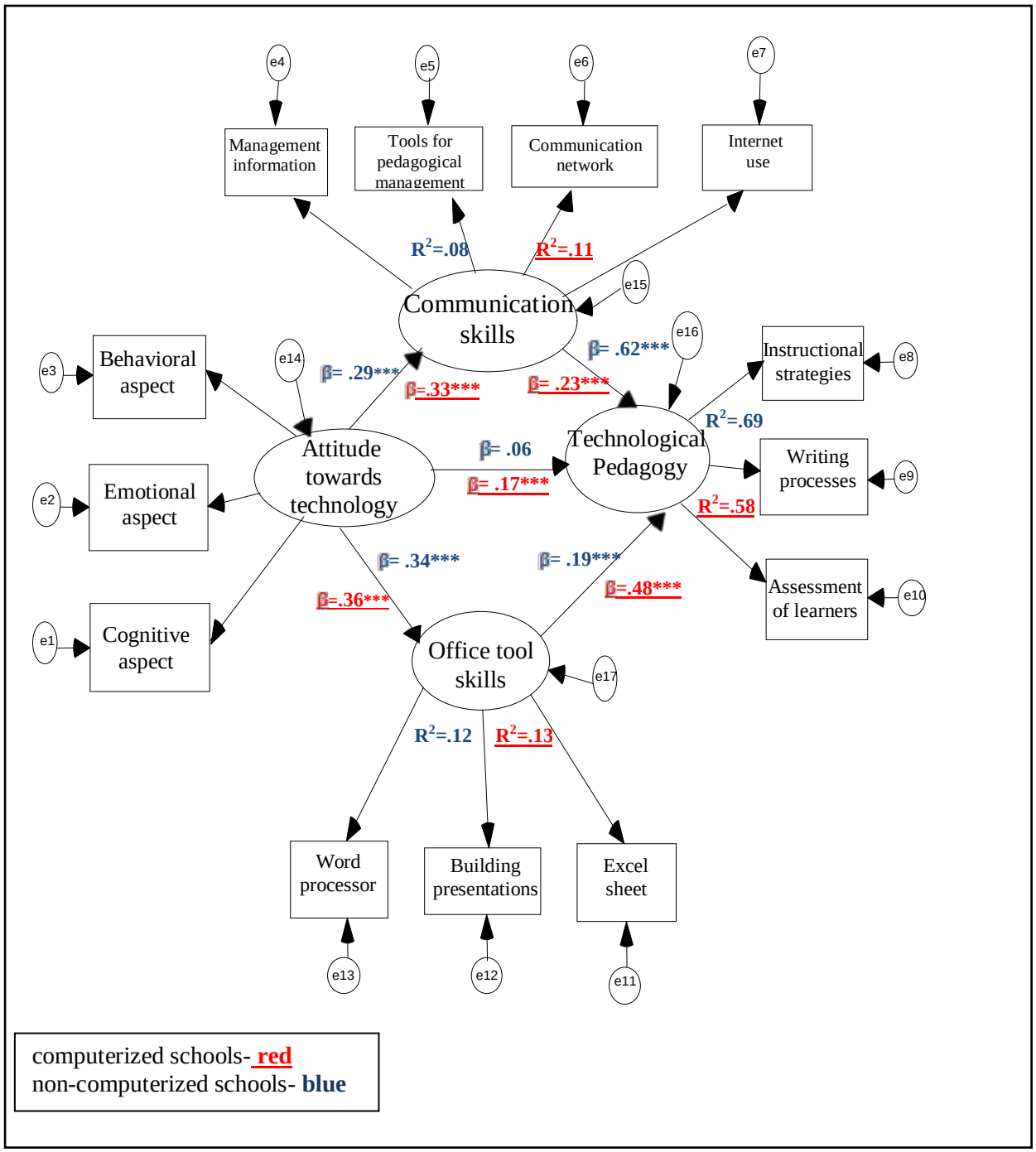

Figure 1: Results of the pathway analysis for the prediction of the level of pedagogy in a technological environment

From Figure 1, we can see that a similar picture in terms of high levels of variance percentages for pedagogy in a technological environment is attained with low levels for office tool skills and communication skills in the non-computerized schools and the computerized schools. In both types of schools, about a tenth of the variance in office tool skills is explained by attitudes

towards technology (12% and 13% respectively). About a tenth of the variance in communication skills is also explained by attitudes towards technology (8% and 11%). About two thirds of the variance of pedagogy in a technological environment is explained by office tools skills, communication skills and attitudes towards technology in the non-computerized schools (69%).

In the computerized schools, about a half of the variance in pedagogy in a technological environment is explained by office tools skills, communication skills and attitudes towards technology in the non-computerized schools (58%). Therefore, it can be seen that in both types of school, the factors included in the model similarly explain the level of office tools skills and communication skills, but that in relation to the level of pedagogy in a technological environment, there is a difference.

This finding emphasizes the uniqueness of the study as the model variables, that include attitudes towards ICT, mastery of office tools, and mastery of communication skills, are very significant amongst teachers working in a computerized environment in such schools compared to non-computerized schools. Hence one may claim that these attributes are central and critical to the ICT teacher.

In addition, we found differences in the marginal contribution of the exogenic variable and each one of the endogenic variables to the prediction of pedagogy in a technological environment.

In computerized schools, the higher the positive attitudes of the teachers towards technology, the higher the level of implementation of technological pedagogy in the classroom ($\beta = .17$, $p<.001$). In contrast, in the non-computerized schools, the level of attitudes towards technology does not show a significant influence on the level of implementation of technological pedagogy in the classroom ($\beta=.06$, $p>.05$). Namely, in non-computerized schools, there is no connection between

attitudes towards technology and implementation of technological pedagogy.

In contrast, upon examining the variable of attitudes towards technology on the moderating variables of office tools skills and communication skills, in both computerized and non-computerized schools, it was found that the recognition of office tools skills and the use of communication skills have a positive significant influence of medium strength on attitudes towards technology, non-computerized schools: (β=.29, β=.34, $p<.001$), computerized schools: (β=.33, β=.36, $p<.001$). Namely, the more the attitude towards technology is positive, the more the teachers use office tools skills and communication skills.

In fact, the endogenic variable of office tools skills in computerized schools has a significant positive influence of high strength on implementation of pedagogy in a technological environment (β=.48, $p<.001$). In contrast, in non-computerized schools, the influence is lower (β=.19, $p<.001$).

Namely, the more teachers are familiar with and use office tools skills, the more the implementation of pedagogy in a technological environment is significantly positive and of greater strength among teachers of computerized schools. Regarding the second endogenic variable, communication skills, the picture is reversed. In non-computerized schools, the influence is significantly positive with high strength on the implementation of pedagogy in a technological environment (β=.62, $p<.001$). In contrast, the influence in computerized schools is less (β=.23, $p<.001$). Namely, the more the teacher is familiar with, and uses communication skills, the greater and the stronger is the use of pedagogical implementation in a technological environment in non-computerized schools.

For this reason, it can be said that in non-computerized schools, the influence of attitudes towards technology on office tools skills and communication skills is more pronounced and the indirect

influence is more significant than the direct influence on implementation of pedagogy in a technological environment.

Discussion and Conclusions

A review of the current ICT programs around the world clearly indicates that teachers play a decisive role in successfully integrating the technology in the class (Anderson, 2008; Kozma, 2008; Linn, 2005). Teachers in the 21st century are expected to learn their renewed role and to adapt to changes in the knowledge era (ISTE, 2008; Webb & Downes, 2003).

The research hypothesis, according to which differences would be found in the level of skill in using office, in the level of communications skills, in the pedagogic application in the technological environment, and in attitudes towards ICT between teachers in computerized schools and teachers in non-computerized schools, was fully confirmed. Teachers in computerized schools have a higher level of office tools skills and communications skills than those in non-computerized schools. Teachers in computerized schools apply pedagogy in a technological environment to a greater extent, and they hold more positive attitudes towards ICT than teachers in non-computerized schools. Researchers who deal with the success of ICT programs note several factors that block the lack of implementation of ICT in education (Anderson & Maninger, 2007; Bauer & Kenton, 2005; Keengwe & Onchwari, 2008), Some of them explain that the main block to successful ICT in teaching is the attitudes of teachers towards its role in teaching-learning-evaluation and a sense of self-efficacy to assimilate ICT in the classroom (Anderson & Maninger, 2007; Bitner & Bitner, 2002; Brinkerhoff, 2006) .

Based on the planned behavior theory, the relevant beliefs influence the guiding factors to perform behavior (Ajzen, 2002). In other words, teachers' relevant beliefs of are significant vis-à-vis their attitudes towards incorporating ICT in teaching, These include positive beliefs regarding teaching in a technological environment as contributing and positive, positive beliefs regarding the expectations of educators to teaching in a technological environment as part of the learning

routine, and strong beliefs regarding the perception of control for teaching in a technological environment. These beliefs are likely to lead to intentions pertaining to teaching in a technological environment, and thereafter to successful performance in practice. Therefore, there it may be necessary to invest in activities intended to develop positive beliefs towards integrating ICT in teaching, which is likely to lead to successful teaching-learning-evaluating in a technological environment.

Computerized schools were selected due to their involvement in ICT for at least four years. They were equipped with ICT infrastructures available to the teacher and the students such as laptop computers for the teachers and the students, an interactive whiteboard and broadband internet. Over the years, the teachers acquired mastery of ICT technologies that included (1) mastery of office tools, word processing, preparing presentations, and data processing-electronic spreadsheets; (2) tools for sharing information and documents, and network communications skills. Network communications enable independent investigation on the one hand, and discussion on the other. Beyond that, they facilitate social interaction that relies on high pedagogic commitment leading to optimal pedagogy. Network communications, tools for pedagogic administration, and correct knowledge management advance quality documentation of the teaching processes. Consideration is not only of the products but also of the students' thought processes. The more a teacher experiences, participates, reacts, alters and improves through knowledge regarding himself and his colleagues, the teachers, so will this contribute to understanding the importance of evaluation processes that will affect evaluation of his students (Iger, Bauman, Yacov & Raviv, 2004). Moreover, the teachers tried ways to integrate ICT technologies in teaching. The teachers were familiar with models and themselves developed models to integrate the tools in the learning processes. The training program included aspects of knowledge and skills to apply the technology in pedagogy. Proper training, that leads to change in the perception of the essence of teaching, enables an educated integration of ICT in teaching

(Davis & Varma, 2008; Fishman et al., 2004; Furman-Shaharabani & Tal, 2008; Halverson & Smith, 2010; Vrma, Husic & Linn, 2008).

For the purpose of investigating the characteristics of Israeli school teachers in a technological learning environment of the 21st century, a pathways systems model was used that included the variables that influence pedagogical implementation in a technological environment. The analysis referred to elementary school teachers in non-computerized schools who are at the beginning of the process of implementing pedagogy in technological environments in comparison to teachers in computerized schools who have taken part in the process for, at least, four years. Findings of the pathway analysis showed differences in the characteristics of teachers in computerized schools in comparison to teachers in non-computerized schools.

The similarity between the teachers in the two groups shows that teachers who are more positive in their attitudes toward technology, and who use office tools and communication skills more, are also higher in their level of pedagogical implementation of technology. Although it can be said that the influence of teachers' attitudes towards technology has an indirect effect on the implementation of technology, the strength of the effect is not the same.

In the case of the teachers from the non-computerized schools, the effect of communication skills is greater than the effect of office tools skills on the implementation of pedagogical technology. We can learn from this that teachers who are at the beginning stages of implementing technology in teaching-learning processes are in need of learning more about internet surfing, tools for pedagogical management, tools for management of personal information and modes of online communication before they will be ready to learn about office tools, such as familiarity with the skills of word processing, building presentations and data analysis on electronic charts, etc.

This finding is in accordance with the claim of Melamed (2010) that in order for teachers to combine technology in their teaching and learning, they must first be familiar with tools for the inclusion of information and documents and know how to develop and manage groups on social networks, be familiar with programs for concept mapping and thought processing and learning systems management, advanced search engines, and tools for organization and analysis of information.

In contrast, the use of office skills among teachers of the computerized schools has a greater influence than communication skills on their pedagogical implementation in a technological environment. This can be explained by the fact that teachers from computerized schools use tools for the management of information and systems for learning management routinely and are, therefore, able to combine the two different kinds of information. These findings strengthen the claims of Mishra and Koehler (2006) that teachers are able to simultaneously combine content knowledge (CK), pedagogical knowledge (PK) and technological knowledge (TK). An expert teacher is one who can take into account the dynamic combination between the different overlapping factors.

Furthermore, for teachers in both types of schools, the factors of our model similarly explain the level of office tools skills and the level of communication skills, but show a difference in pedagogical implementation in a technological environment. In non-computerized schools, the percentage of variance of pedagogical implementation is higher than in computerized schools. Namely, attitudes towards technology, use of office tools and communication tools better explain the variance in pedagogical implementation in a technological environment for teachers in non-computerized schools than for teachers in computerized schools. A possible explanation for this is that implementation of information technology for teaching-learning-assessment processes in the beginning stages require a combination of the following things: positive attitudes toward

technology, use of technological tools and skills of online communication.

In contrast, teachers from computerized schools received widespread and systematic training that included technological knowledge and pedagogical-technological content knowledge that appears to influence pedagogical implementation in a technological environment. Concerning the use of computers in instruction, it has been shown that with no appropriate and ongoing teacher professional development with clear goals, some of the technological tools will not find expression in effective instruction in the classroom (Dunleavy, Dexter & Heinecke, 2007). In this study, the variable of the training that the teachers received was not taken into account. In further research, it is advisable to examine the influence of the nature of the training on the implementation of technology in actual situations in the classroom.

The main barrier to implementing technology in the classroom is the teachers' attitudes towards the role of technology in education and their ability to successfully implement it. Therefore, if teachers believe in implementing technology in instruction and if they have the knowledge to practically do so, they will implement technology in the course of their work (Anderson & Maninger, 2007; Bitner & Bitner, 2002; Brinkerhoff, 2006; Harris & Hofer, 2009).

The findings of this research provide evidence that positive attitudes towards technology are not sufficient for implementing technology in instruction. In order to assure that teachers will implement technology in the course of their work, there is a need to train them to do so. We recommend that professional development courses for teachers be based on acquisition of technological knowledge and pedagogical-technological knowledge. In the first stage, technical knowledge needs to include communication skills. In the second stage, specific skills of technological tools that can be implemented in various disciplinary subjects are necessary.

Moreover, in order for teachers to implement technology in their work in the 21st century, it is necessary to train them to adopt new technology by means of the use of the internet and communication skills. The focus should be on new instructional skills based on combined technological-pedagogical content knowledge that contribute to the implementation of optimal instruction in innovative environments.

Research Limitations and Suggestions for Further Research

Despite the above, it is important to note several limitations and raise suggestions for future research. Since the research was conducted at the start of the application of the new national ICT program in Israel, its impact on teachers in both ICT computerized and in non-computerized schools could not be observed. Emphasis is placed in the ICT program on the teachers' professional development, in order to train them to teach in an ICT environment, where the input of the program is more considerable in computerized schools. But the teachers in both types of school have still not benefited from the input. Therefore the differences between them stem from the situation prior to the ICT program. In other words, the teachers in the computerized schools are those with experience in integrating ICT in teaching, and they teach in schools where the digital culture has been assimilated. In contrast, teachers in the non-computerized schools lack experience and training for teaching in an ICT environment and there is no assimilation of digital culture in their schools. In view of this, the attributes of teachers in an ICT environment should be examined after two years of participation in the national ICT program that is intended to expose the teachers to the most cutting edge pedagogic innovation.

The current study deals with the attributes of teachers in an ICT environment, where the focus is on the TPACK evaluation of the teachers and their attitudes towards ICT. We recommend completing the research by exploring the sense of capability of the teachers in an ICT environment, and thus examining the connection between the attributes of the teachers in general and their attributes in an ICT environment. Such an examination is likely to contribute to deeper understanding of the significance of unique attributes of the ICT teacher.

Similarly, studies find that assimilating processes of change in teaching methods entails considerable difficulty (Halverson & Smith, 2010; Selwyn, 2010). Therefore, we recommend continuing the study after a period of time, and examining the changes that occurred amongst the teachers, and the profile of the teacher using ICT.

Finally, we recommend integrating qualitative research that includes interviews with teachers, in order to obtain deeper information pertaining to the beliefs and attitudes of the teachers regarding integrating ICT in teaching, and to examine the significance of the differences between teachers whose ICT abilities are advanced and beginners.

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Appendix 1:
Pedagogic-Technological Questionnaire

Dear teacher,

Before you is a questionnaire intended to evaluate the extent to which you use an ICT environment for teaching and learning needs, and thus to obtain information for professional development in the program known as "Adapting het education system to the 21st century skills".
Please complete the questions carefully, and on conclusion press the "submit" button.
Thank you in advance for your cooperation

Part 1 Complete regarding yourself

- Name of school
- Type of school (elementary/junior high school
- Locale
- District
- Gender
- Subject taught
- Academic education
- Number of years of teaching seniority

Part 2

Note the degree of your knowledge and your use of it: 1 - No knowledge; 2 – Have knowledge but not used; 3 - Have knowledge and use it

	1	2	3
1. Degree of use of ICT tools			
1.1 Managing files			
1. Organizing, locating, and seeking information in folders on the disc			
2. Handling file: saving, copying, deleting			
1.2 Word processing			
3. Writing and design of text			
4. Adding autoshapes, use of drawing ruler and word art design			
5. Adding picture, altering font size, choosing a section from it			
6. Adding table and its design, text wrap, return to headings			
7. Adding hyperlink (to the site, file, other place in the document, bookmark)			
1.3 Preparing a presentation			
8. Creating slides comprising text, graphics, pictures			

9. Creating references within a presentation: to a site, to a file, slides			
10. Adding a filmstrip, picture, animation, voice			
1.4 Electronic spreadsheet			
11. Writing a textual or numerical value in the spreadsheet cells			
12. Use of simple functions: average, sum			
13. Use of chart wizard to create a graph			
1.5 Internet surfing			
14. Search for information using a search engine			
15. Cataloguing favorite sites in folders you created			
16. Downloading/saving files and pictures from the internet			
1.6 Network communications			
17. Use of email: receiving sending, forwarding, attaching file			
18. Email address book			
19. Use of IM software such as Googletalk, ICQ, MSN			
20. Writing responses in a forum or blog			
1.7 Tools for pedagogic management			
21. Use of Manbass/MANBASSON/ other pedagogic management tools			
22. Use of information management system to produce reports and determine learning tracks in the learning environment such as OFEK, GALIM, ELNET, TIME TO KNOW			
2. Teaching in an ICT environment			
2.1 Teaching strategies in a computerized environment			
23. I use a computer and a projector and/or computers in my classroom to present, explain or illustrate information			
24. I put learning assignments and/or content on the school site			
25. I usually give my students computerized assignments intended for practice and repetition, for solving problems and for using sources of information			
26. I develop computerized assignments in diverse subjects (at least 2 assignments annually)			
27. I guide my students to be aware of possible dangers connected to the use of the internet such as invasion of their privacy,			

addiction to the network, copyright, intellectual property, slander etc.			
2.2 Writing in a computerized environment			
28. I use computerized tools (word processor) for writing documents, activity sheets, papers, tests etc.			
29. I develop writing assignments using diverse ICT tools for my students: Word processing, presentations, blogs, discussion groups			
30. I use the various digital functions to advance my students' writing (correcting writing mistakes, writing comments, saving drafts, dictionary etc.			
31. I direct my students to manage a digital portfolio of their work			
32. I offer my students shared writing tasks using tools that enable shared writing such as discussion groups, wiki, blogs			
33. I teach my students skills for rewriting and editing text (layout, paragraphs, numbering)			
2.3 Evaluating students in an ICT environment			
34. I use assignments and/or computerized tests that I prepared by myself to evaluate my students			
35. I use ready assignments and/or computerized tests to evaluate my students			
36. I evaluate my students using a digital portfolio			
37. I use computerized tools to gather data for evaluation and tracking my students' progress			
38. I provide feedback to my students using ICT tools such as email, forums, blogs, wiki			
39. I use computerized tools to analyze and process findings to draw conclusions			
40. I publish the students' results on the network for colleague evaluation			

Part 3: Attitudes towards the use of ICT

Note the extent of your agreement with the following statements: 1- Disagree; 2 – Agree to some extent; 3 – Agree; 4 - Fully agree

	1	2	3	4
41. The use of computers increases work efficiency				

42. Incorporating the computer in teaching enables providing a response to different learning styles				
43. Incorporating the computer in teaching enables offering a solution to diverse areas of interest				
44. The computer enables developing the students' cognitive skills				
45. The use of a computer develops learning skills (reading, writing, merging texts, search for information etc) amongst students				
46. The advantages of the computer outweigh the disadvantages				
47. Integrating the computer in learning contributes to advancing their students' achievements.				